Monolithic 2x2 Amplifying Add/Drop Optical Switch for Data Networking

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Optical space switches offer a compact means for routing high capacity wavelength division multiplexed data for next generation system area networks. Semiconductor optical amplifiers (SOA) may be used as gates in switch fabrics to allow nanosecond switching times, less than –40dB crosstalk, and lossless routing. In this work, we propose and demonstrate an integrated optical circuit based on SOA gates and splitters for use in high speed optical routing.

A two input, two output switch suited to add drop multiplexing of optical packets is demonstrated using a grid of eight semiconductor optical amplifiers as shown in figure 1. The devices are designed for ease of fabrication, assembly and test. The four input and output amplifiers comprise waveguide splitters which taper linearly from a single mode ridge waveguide to terminate at one of four waveguide crossings. At the waveguide crossings, four total internal reflecting (TIR) mirrors are fabricated at 45º to the waveguide using focussed ion beam etching. An area of 4µm x 0.5µm is removed with high side wall verticallity to a depth below the active and optical confinement layers at the end point of each SOA splitter. Short SOA gates for enhanced dynamic range are placed between the splitter SOAs to link the two inputs to the two outputs to allow both switched and broadcast operation. For ease of processing, antireflection coating is performed prior to die cleaving. Two opposing facets are coated to 0.5% over the C-band while the remaining two facets are as-cleaved. Designs with all the inputs and outputs on AR coated facets have been fabricated.

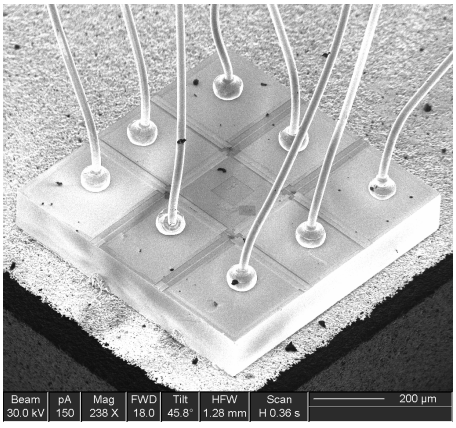

Figure 1: Secondary ion image of a two input two output optical switch with total internal reflecting mirrors formed by focussed ion beam etching.

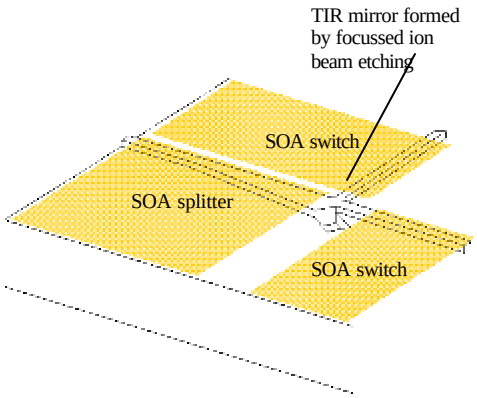

Figure 2: Schematic diagram of the basic 1x2 element as implemented four times to form the 2x2 switch matrix.

The four input/output splitter amplifiers are separately DC biased, while the remaining gate amplifiers are electrically switched for fast routing operation. For CW input power of +2.5dBm at wavelength 1550nm, the through port output power was measured to be –4.5dBm while the drop port was measured to be –8.0dBm. Accounting for a reflectivity of 30% at the as-cleaved facet gives a beam splitter ratio of 60:40, and a balanced output is readily achieved by current adjustment. A coupling loss of 8dB is estimated for each of the fibre lenses, indicating an on chip gain of 9dB. Initial tests were performed for 50mA for each electrode and the switch fabric was operating in saturation mode with compromised gain. Performance will improve for the condition where the SOA splitters are operated at transparency, the short SOA gates are operated at high gain, and for lower optical input power.

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